IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of :

Frederic HOFFMANN et al. Group Art Unit: Unassigned

Serial No.: Unassigned Examiner: Unassigned

Filed: Herewith

For: THIN MULTI-STAGE CATALYTIC REACTOR WITH INTERNAL HEAT EXCHANGER, AND USE THEREOF

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to initial examination, please amend the above-identified application as follows:

IN THE ABSTRACT:

Please replace the existing Abstract with the attached new Abstract of the Disclosure.

IN THE CLAIMS:

Please amend the claims as follows:

4. (Amended) A reaction vessel according to claim 3, comprising means for moving the catalyst and reaction fluids in a generally co-current motion along the axis of the vessel.

5. (Amended) A reaction vessel according to claim 1, comprising at least two stages (6, 7) and at least two reaction zones (12a, 12d) per stage.

6. (Amended) A reaction vessel according to claim 1, comprising three to twelve reaction zones, limits included.

7. (Amended) A reaction vessel according to claim 1, wherein at least one of the reaction zones has a substantially planar cross section.

8. (Amended) A reaction vessel according to claim 1, wherein at least one of the reaction zones has a substantially annular cross section.

9. (Amended) A reaction vessel according to claim 1, wherein at least one of the reaction zones has a substantially elliptical cross section.

10. (Amended) A reaction vessel according to claim 1, comprising downstream of the heat exchange means in the direction of motion of the reaction fluids, at least one means (304, 804, 805) for mixing of the reaction fluids from the heat exchange means prior to their introduction into the reaction zone located downstream of said heat exchange means.

11. (Amended) A reaction vessel according to claim 1, wherein the means for transporting reaction fluids from one stage to the lower stage are disposed substantially in the proximity of the central axis of the vessel.

12. (Amended) A reaction vessel according to claim 1, further comprising a means (616) placed substantially at the centre of at least one stage for separating the reaction fluids into a plurality of streams, each stream then separately traversing a succession of reaction zones (606, 605, 604; 601, 602, 603) and heat exchange means (613, 614, 615; 611, 612, 615) within that stage.

13. (Amended) A reaction vessel according to claim 1, wherein at least one of the heat exchange means comprises a series of finned tubes, the reaction fluids moving externally of said tubes.

14. (Amended) A reaction vessel according to claim 1, wherein at least a portion of said heat exchange means is disposed between two successive stages.

15. (Amended) In a process comprising dehydrogenating linear paraffins containing between about 3 and about 20 carbon atoms, the improvement wherein the dehydrogenating is conducted in a reaction vessel according to claim 1.

16. (Amended) In a process comprising producing aromatic compounds having at least one substituent on the aromatic cycle which is a linear aliphatic chain containing about 3 to about 20 carbon atoms, and comprising a step of forming mono-olefinic compounds, the improvement comprising conducting the process in a reaction vessel according to claim 1.

17. (Amended) A process for converting a hydrocarbon feed employing a reaction vessel comprising at least two catalytic reaction stages according to claim 1, wherein the feed is moved substantially transversely in at least one reaction zone of a first stage of the vessel at a suitable temperature, a reaction fluid is recovered at the outlet from the reaction zone, heat is exchanged between the reaction fluid and a heat exchange fluid in at least one heat exchange zone located downstream of the reaction zone and inside the vessel and after heat exchange, the reaction fluid is moved into at least one reaction zone of a subsequent stage, a conversion effluent being recovered from the final stage of the reaction vessel, the residence time of the catalyst in each reaction zone and the hourly space velocity of the feed being determined to limit the temperature variation in each reaction zone and heat exchange being controlled to adjust the temperature of the reaction fluid entering the reaction zone to a level substantially at most equal to the temperature of the reaction fluid entering the preceding zone.

21. (Amended) A process according to claim 17, in which the hourly space velocity, defined as the ratio of the mass flow rate of feed or reaction fluid to the mass of catalyst contained in the reaction zone, is between 1 and 100 h^{-1}, or between 5 and 30 h^{-1}.

22. (Amended) A process according to claim 17, in which the residence time for the feed in each reaction zone is in the range of 0.01 s to 1 s, or in the range of 0.03 to 0.1 s.

23. (Amended) A process according to claim 17, in which the catalyst moves in each reaction zone at a speed in the range of 1 cm/h to 20 cm/h, or in the range of 2 cm/h to 10 cm/h.

24. (Amended) A process according to claim 17, in which the variation in temperature in one reaction zone is limited to a value in the range 2°C to 50°C, or to a value in the range 5°C to 15°C.

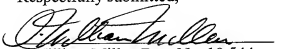
25. (Amended) A process according to claim 17, in which a portion of the catalyst is extracted from the outlet from the vessel, regenerated in at least one regeneration zone located outside the vessel and re-introduced into the reaction zone inside the vessel.

REMARKS

A principal purpose of this Preliminary Amendment is to remove the multiply dependent claims and avoid the fee associated therewith, applicant reserving the right to reintroduce claims to canceled combined subject matter.

The Commissioner is hereby authorized to charge any fees associated with this response or credit any overpayment to Deposit Account No. 13-3402.

Respectfully submitted,



I. William Millen Reg. No. 19,544
Attorney for Applicant(s)

MILLEN, WHITE, ZELANO
& BRANIGAN, P.C.
Arlington Courthouse Plaza 1, Suite 1400
2200 Clarendon Boulevard
Arlington, Virginia 22201
Telephone: (703) 243-6333
Facsimile: (703) 243-6410

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ABSTRACT OF THE DISCLOSURE

An elongate reaction vessel and process includes at least two stages in the vertical direction in which an endothermic or exothermic catalytic reaction is carried out and comprises: a catalytic reaction zone (12a, 12b) per stage (6, 7); introducing (2) a reaction fluid to a stage adapted for transverse motion of the fluid across the whole vertical extent of the reaction zone; introducing and extracting the catalyst; a heat exchanger (5a) for reaction fluids located inside the vessel between two successive reaction zones; means (6) for transporting reaction fluids from one stage to another preferably connected to the exchanger of the stage under consideration and to the inlet for reaction fluids of the subsequent stage; and means for recovering reaction fluids downstream of the last stage. The temperature variation in each zone and the temperature level are respectively adjusted by the thickness of each zone and by heat exchange.

VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Abstract

The abstract has been replaced with the attached new Abstract of the Disclosure, therefore no marked-up version is necessary.

In the Claims

The claims have been amended as follows:

4. (Amended) A reaction vessel according to claim 3, ~~characterized in that~~ comprising means for moving the catalyst and reaction fluids ~~move~~ in a generally co-current motion along the axis of the vessel.

5. (Amended) A reaction vessel according to ~~any one of claims 1 to 4~~ claim 1, comprising at least two stages (6, 7) and at least two reaction zones (12a, 12d) per stage.

6. (Amended) A reaction vessel according to ~~any one of claims 1 to 5~~ claim 1, comprising three to twelve reaction zones, limits included.

7. (Amended) A reaction vessel according to ~~any one of claims 1 to 6, characterized in that~~ claim 1, wherein at least one of the reaction zones has a substantially planar cross section.

8. (Amended) A reaction vessel according to ~~any one of claims 1 to 6, characterized in that~~ claim 1, wherein at least one of the reaction zones has a substantially annular cross section.

9. (Amended) A reaction vessel according to ~~any one of claims 1 to 6, characterized in that~~ claim 1, wherein at least one of the reaction zones has a substantially elliptical cross section.

10. (Amended) A reaction vessel according to ~~any one of claims 1 to 9~~ claim 1, comprising~~,~~ downstream of the heat exchange means in the direction of motion of the reaction fluids, at least one means (304, 804, 805) ~~encouraging~~ for mixing of the reaction fluids from the heat exchange means prior to their introduction into the reaction zone located downstream of said heat exchange means.

11. (Amended) A reaction vessel according to ~~any one of claims 1 to 10, characterized in that~~ claim 1, wherein the means for transporting reaction fluids from one stage to the lower stage are disposed substantially in the proximity of the central axis of the vessel.

12. (Amended) A reaction vessel according to ~~any one of claims 1 to 11, characterized in that~~ claim 1, further comprising a means (616) placed substantially at the centre of at least one stage ~~separates~~ for separating the reaction fluids into a plurality of streams, each stream then separately traversing a succession of reaction zones (606, 605, 604; 601, 602, 603) and heat exchange means (613, 614, 615; 611, 612, 615) within that stage.

13. (Amended) A reaction vessel according to ~~any one of claims 1 to 12, in which~~ claim 1, wherein at least one of the heat exchange means comprises a series of finned tubes, the reaction fluids moving externally of said tubes.

14. (Amended) A reaction vessel according to ~~any one of claims 1 to 13, in which~~ claim 1, wherein at least a portion of said heat exchange means is disposed between two successive stages.

15. (Amended) ~~Use of a reaction vessel according to any one of claims 1 to 14 for~~ In a process comprising dehydrogenating linear paraffins containing between about 3 and about 20 carbon atoms, the improvement wherein the dehydrogenating is conducted in a reaction vessel according to claim 1.

16. (Amended) ~~Use of a reaction vessel according to any one of claims 1 to 14 in~~ In a process ~~for~~ comprising producing aromatic compounds having at least one substituent on the aromatic cycle ~~of~~ which is a linear aliphatic chain~~, in general an alkyl chain,~~ containing about 3 to about 20 carbon atoms, and ~~wherein one of the steps is the formation of~~ comprising a step of forming mono-olefinic compounds, the improvement comprising conducting the process in a reaction vessel according to claim 1.

17. (Amended) A process for converting a hydrocarbon feed employing a reaction vessel comprising at least two catalytic reaction stages according to ~~any one of claims 1 to 14, characterized in that~~ claim 1, wherein the feed is moved substantially transversely in at least one reaction zone of a first stage of the vessel at a suitable temperature, a reaction fluid is recovered at the outlet from the reaction zone, heat is exchanged between the reaction fluid and a heat exchange fluid in at least one heat exchange zone located downstream of the reaction zone and inside the vessel and after heat exchange, the reaction fluid is moved into at least one reaction zone of a subsequent stage, a conversion effluent being recovered from the final stage of the reaction vessel, the residence time of the catalyst in each reaction zone and the hourly space velocity of the feed being determined to limit the temperature variation in each reaction zone and heat exchange being controlled to adjust the temperature of the reaction fluid entering the reaction zone to a level substantially at most equal to the temperature of the reaction fluid entering the preceding zone.

21. (Amended) A process according to ~~any one of claims 17 to 20~~ claim17, in which the hourly space velocity, defined as the ratio of the mass flow rate of feed or reaction

fluid to the mass of catalyst contained in the reaction zone, is between 1 and 100 h^{-1}, ~~preferably~~ or between 5 and 30 h^{-1}.

22. (Amended) A process according to ~~any one of claims 17 to 21~~ claim 17, in which the residence time for the feed in each reaction zone is in the range of 0.01 s to 1 s, ~~preferably~~ or in the range of 0.03 to 0.1 s.

23. (Amended) A process according to ~~any one of claims 17, 19 to 22~~ claim 17, in which the catalyst moves in each reaction zone at a speed in the range of 1 cm/h to 20 cm/h, ~~preferably~~ or in the range of 2 cm/h to 10 cm/h.

24. (Amended) A process according to ~~any one of claims 17 to 23~~ claim 17, in which the variation in temperature in one reaction zone is limited to a value in the range 2°C to 50°C, ~~preferably~~ or to a value in the range 5°C to 15°C.

25. (Amended) A process according to ~~any one of claims 17 to 24~~ claim 17, in which a portion of the catalyst is extracted from the outlet from the vessel, regenerated in at least one regeneration zone located outside the vessel and re-introduced into the reaction zone inside the vessel.